MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2017/2018

EOP4086 OPTICAL SIGNAL PROCESSING (OPE)

30TH May 2018
9.00A.M – 11.00 A.M
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 4 pages including the cover page with 4 Questions only.

2. Attempt FOUR out of FOUR questions. All questions carry equal marks and the distribution of marks for each question is given.

3. Please print all your answers in the Answer Booklet provided.

Question 1 **[25 marks]**

(a) A source of light with a wavelength of 600 nm is incident normally on a diffraction grating. From the observation, two adjacent maxima occur at angles given by $\sin\theta = 0.2$ and $\sin\theta = 0.3$. The fourth and eighth-order maxima are missing.

(i) At what angle does the maxima of a diffraction grating occur? Calculate the separation between the adjacent slit.

[5 marks]

(ii) At what angle does the minima of a single-slit diffraction occur? Estimate the smallest slit width this grating can have.

[5 marks]

(iii) Determine which orders of intensity maxima are produced by the grating.

[5 marks]

(b) Two spectral lines have wavelengths λ and $\lambda + d\lambda$ respectively. State the grating equation and prove that if $d\lambda << \lambda$, the angular separation $d\theta$ in a grating spectrometer is $d\theta = \dfrac{d\lambda}{\sqrt{\left(\dfrac{e+d}{n}\right)^2 - \lambda^2}}$, where $(e+d)$ is the grating element spacing and n is the order at which the lines are observed.

[10 marks]

Continued ...

Question 2 [25 marks]

(a) (i) Coherence length is the propagation distance over which a coherent wave maintains a specified degree of coherence. Establish the relation between coherence length and bandwidth.

[7 marks]

(ii) Calculate the coherence length for CO_2 laser whose line width is $1x\ 10^{-5}$ nm at IR emission wavelength of 10.6 μm.

[3 marks]

(b) Explain in your own words, is strictly monochromatic light realizable practically?

[4 marks]

(c) With the aid of suitable diagrams, explain the basic idea of temporal coherence of the light beam.

[11 marks]

Question 3 [25 marks]

(a) With the aid of a suitable diagram, describe how Fourier Transform and inverse transform can be achieved optically using lenses.

[8 marks]

(b) A Michelson interferometer forms fringes with cadmium red light of 643.8 nm and line width of 0.0015 nm.

(i) What is the visibility of the fringes when one mirror is moved 1 cm from the position of zero path difference between arms?

[4 marks]

(ii) What are the changes in visibility that can be observed when the distance moved is 5 cm?

[2 marks]

(iii) Calculate the distance where the visibility goes to zero.

[4 marks]

(c) State and prove convolution theorem in Fourier optics.

[7 marks]

Continued ...

Question 4 [25 marks]

(a) Describe, with a schematic diagram and mathematical descriptions, the working principle of a recording hologram.

[7 marks]

(b) Show that for a double-slit with a slit width of b and widths separation of Fraunhofer diffraction, the ratio of widths of the central diffraction peak to the central interference fringe is $2(a/b)$.

[10 marks]

(c) Briefly describe the Holographic Endoscope in your own words. Your answer should include description of internal and external recording endoscope.

[8 marks]

End of Paper